Poseidon 533/2
Cruise Report

Las Palmas (Gran Canaria) 25. March

Ponta Delgada (Azores) 1. April 2019

Captain: Matthias Günther

POS 533/2 - Energy Transfer III

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1. Summary

1.1 Summary in English

The Poseidon cruise POS533/2 was part of the observational program of the TRR181, an interdisciplinary research program of the Deutsche Forschungsgemeinschaft (DFG). The overarching aim of the TRR181 ‘Energy transfers in atmosphere and ocean’ is the energetically consistent representation of the oceanic and atmospheric energy cycles in climate models. After POS516 (2017) and POS523 (2018) the cruise POS533/2 was the third expedition to the area south of the Azores within the TRR181.

Tidal forcing excites so-called internal tides at steep topography such as seamounts and the continental shelf. These internal tides have the form of underwater waves that may travel hundreds of kilometers across ocean basins. Along their paths, the waves lose their energy by a range of processes and interactions, but the how and where is mostly unknown.

South of the Azores seamounts generate very energetic internal tides which radiate energy towards the Cap Verde Islands. During POS516 and POS523 we conducted a spatial survey to better understand the fluxes and dissipation of the internal tides. A mooring measuring time series of temperature and current velocities was redeployed at 30°29’N, 30°12’W during POS523 in May 2018. Its data will be used to study the temporal variability in the energy of the internal tides. With the successful retrieval of this mooring, the goal of POS533/2 was fully achieved.

1.2 Zusammenfassung

Die Poseidon Fahrt POS533/2 war Teil des Beobachtungsprogramms des TRR181, eines interdisziplinären Forschungsprogramms der Deutschen Forschungsgemeinschaft (DFG). Übergeordnetes Ziel des TRR181 "Energietransfers in Atmosphäre und Ozean" ist die energetisch konsistente Darstellung der ozeanischen und atmosphärischen Energiekreisläufe in Klimamodellen. Nach POS516 (2017) und POS523 (2018) war die Fahrt POS533/2 die dritte Expedition in das Gebiet südlich der Azoren im Rahmen des TRR181.

Die barotrope Gezeit regt an steiler Topographie wie Seamounts und dem Kontinentalhang so genannte interne Wellen an. Diese internen Wellen können sich durch das Ozeanbecken Hunderte von Kilometern ausbreiten. Auf ihrem Weg verlieren die Wellen ihre Energie durch eine Reihe von Prozessen und Wechselwirkungen, aber das Wie und Wo ist weitgehend unbekannt.

Südlich der Azoren erzeugen Seamounts sehr energiereiche interne Wellen, die Energie in Richtung der Kapverdischen Inseln transportieren. Während POS516 und POS523 haben wir eine räumliche Untersuchung durchgeführt, um die Flüsse und die Dissipation der internen Wellen besser zu verstehen. Eine Verankerung zur Messung von Temperatur und Strömungsgeschwindigkeiten wurde während POS523 im Mai 2018 bei 30°29'N, 30°12'W erneut ausgelegt. Die Daten die durch diese Verankerung gemessen werden, dienen der Untersuchung der zeitlichen Variabilität der Energie der internen Wellen. Mit der erfolgreichen Bergung dieser Verankerung wurde das Ziel von POS533/2 vollständig erreicht.

2. Participants / Teilnehmer

1	Janna Köhler	Chief Scientist	University Bremen
2	Jonas Löb	Mooring instrumentation	University Bremen
3	Wolfgang Böke	Technician	University Bremen
4	Boris Kisjeloff	Technician	GEOMAR, Kiel

Figure 1: Scientific crew during POS533/2, left to right: Wolfgang Böke, Janna Köhler, Jonas Löb, Boris Kisjeloff

3. Research Program

The Poseidon cruise POS533/2 to the area south of the Azores was part of project W2 in the TRR181 „Energy Transfers in Atmosphere and Ocean“. The aim of the subproject „W2 Energy transfer through low-mode internal waves“ is the analyses of the energy transfer by

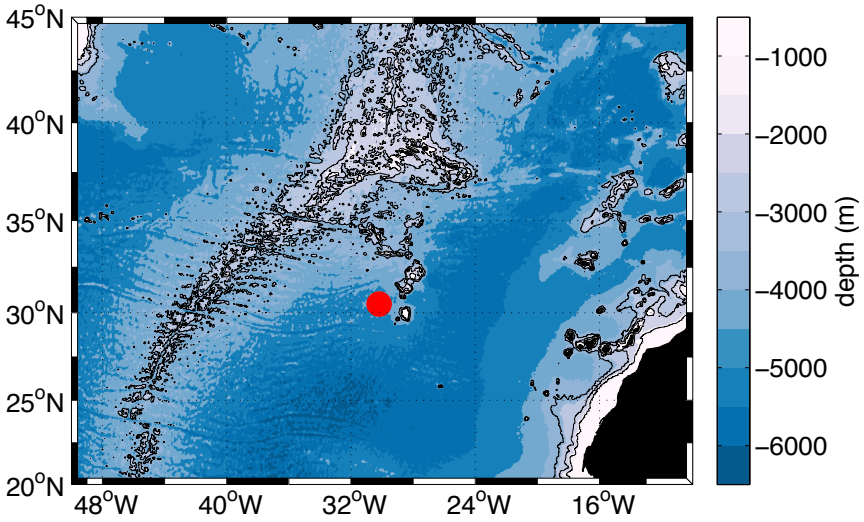

Figure 2: Mooring location (red dot) close to a seamount chain south of the Azores. Bathymetry from Amante and Eakins (2009).

low-mode internal waves with a focus on the region south of the Azores. The region between the Azores and the Cape Verde archipelago in the east Atlantic is ideally suited for this kind of process study, because it is an area of a strong internal tide signal radiating away from the seamount chain south of the Azores.

Figure 3: Aquadopp current meters in the lab after the mooring recovery.

Low-mode waves are crucial for interior mixing and for the oceanic energy pathways, as they possess a large portion of the kinetic energy of the entire wave field and are able to travel basin-wide before they break and contribute to dissipation and mixing in regions far away from their generation sites. The goal of this cruise was the recovery of a mooring dedicated to observations of the temporal variability in internal wave energy fluxes and of the energy flux from the wind field via the mixed layer into the internal wave field.

4. Narrative of the Cruise

We left the port of Las Palmas on Gran Canaria at noon on March 25 with a delay of 27h as we had to wait for the customs clearance of a container from the previous cruise. During the approximately 4-day transit to the mooring position, we carried out a 2000 m Conductivity/Temperature/Depth- (CTD) Profile at 9:00 UTC on the 28th of March to take water samples that were used for conductivity calibrations.

In the morning of Friday 29th March we arrived at the mooring position at 30°29'N, 30°12'W, and released it at 7:34 UTC. After a successful recovery, all instruments were back on deck at 10:47 UTC. Thanks to the great work of the captain and crew of the Poseidon, all our instruments could be retrieved in good condition, having been in the ocean for ten months since May 2018.

Right after the mooring recovery and a shallow CTD cast for sensor calibration, we set course towards Ponta Delgada (Azores) where we arrived in the morning of Monday 1st of April.

5. Preliminary Results

Recovery of mooring ET2 (J. Löb)

On Friday, March 29th, we successfully recovered the mooring ET2 deployed during POS523 in May 2018. The mooring was equipped with a total number of 8 current meter/ temperature logger pairs consisting of 7 Nortek Aquadopp current meters with either a Sea-Bird SBE56 or a Sea-Bird SBE39plus temperature logger and one DVS current meter paired with a SBE56 temperature logger. Additionally, 17 Nautilus 17" floats, 2 acoustic releasers and an upward looking 150 kHz TRDI ADCP mounted in a 32" float with radio and iridium beacon were part of the mooring. In total the mooring had a length of 4300 m. All instruments were retrieved in good condition and measured as planned. After recovery, all data were downloaded and the instruments were serviced and prepared for transport. The raw data show both long-term variability as well as a strong tidal signal (Fig. 4).

The measured time series of current velocity and temperature will be used to calculate time series of internal wave energy fluxes in the near-inertial and tidal frequency bands. The near surface ADCP (Quartermaster) covered the depth range from the top of the mooring to the sea surface. Data from this instrument will be used to estimate the wind energy input via the mixed layer into the internal wave field.

In particular the deployed instruments and their settings used in ET2 were the following:

5.1 ADCP (RDI Workhorse Quartermaster):

The TRDI Workhorse Quartermaster is an Acoustic Doppler Current Profiler (ADCP), which was mounted in the top buoy of the mooring. The instrument settings were: frequency: 153600 Hz, sampling interval: 18 s, pings per ensemble: 35, first cell range: 12.21 m, last cell range: 332.21 m, standard deviation: 1.20 cm/s. The settings were chosen as a compromise between measurement range and accuracy in the deployment environment in combination with battery life.

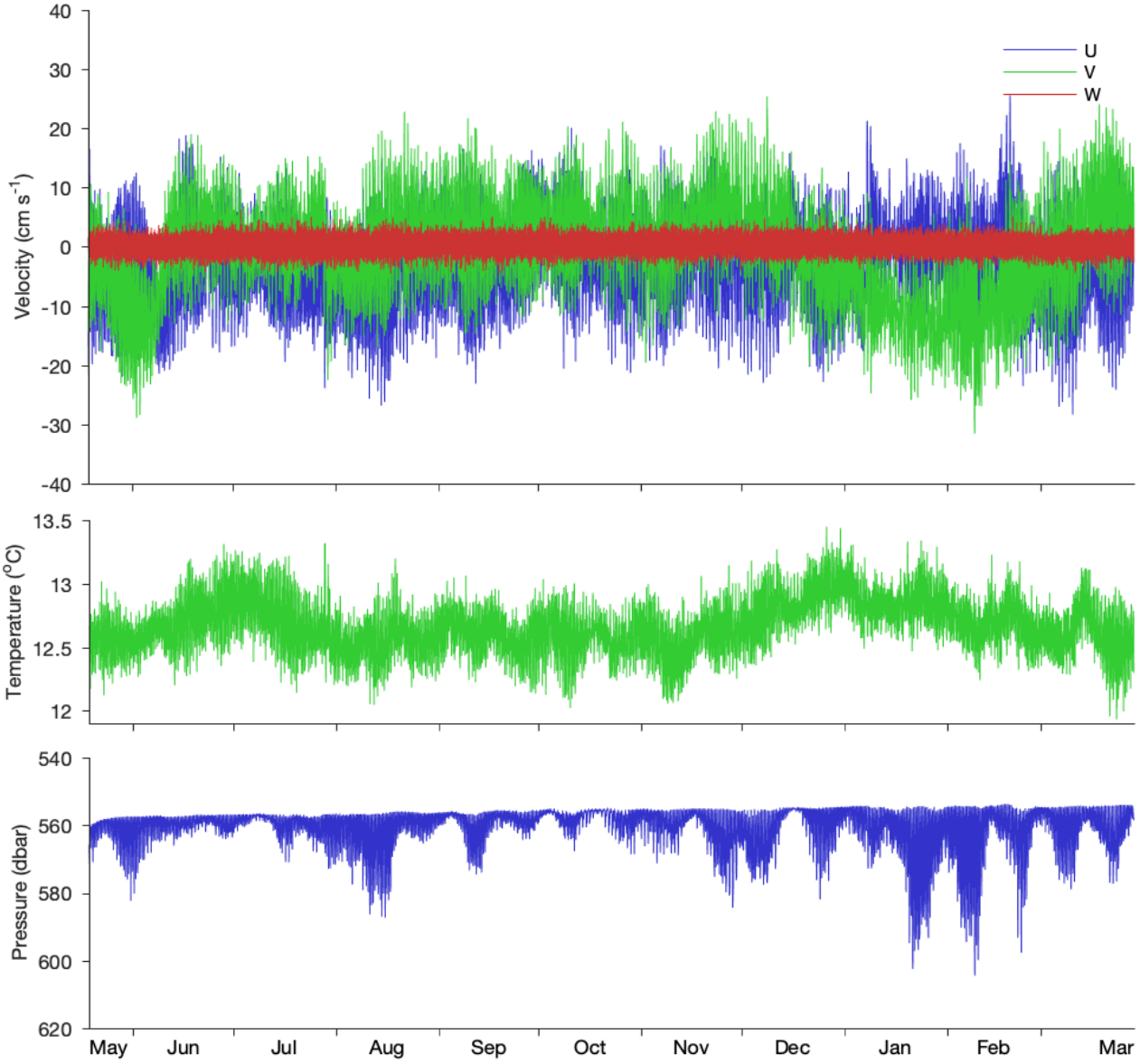

Figure 4: Raw time series of horizontal and vertical velocities, temperature and pressure measured by the uppermost Aquadopp current meter in the mooring.

5.2 Doppler Volume Sampler (RDI DVS) with pressure sensor

The TRDI doppler volume sampler is a high-frequency (2500 kHz) current profiler, measuring over a distance of up to 3 m with a maximum of 5 velocity bins. The starting time was set to 18.05.2018 at 08:00. The instrument settings were: frequency: 2457.6 kHz, sampling interval: 600 s, pings per ensemble: 19, number of depth cells: 5, depth cell size: 0.8 m, blanking distance: 0.3 m, first cell range: 1.13 m, last cell range: 4.33 m, max range: 4.73 m, standard deviation: 0.5 cm/s.

5.3 Nortek Aquadopp current profilers with pressure sensor

The Aquadopp profiler measures three-component (east, north, up) current velocity data using acoustic Doppler technology. The start time and configuration of all 7 Aquadopp current meters were the same. The starting time was set to 18.05.2018 at 08:00. The instrument settings were: measurement interval: 600 s, average interval: 30 s, blanking distance: 0.5 m, diagnostics interval: 24 h, compass update rate: 1 s, coordinate system: ENU, speed of sound: 1500 m/s.

5.4 Sea-Bird SBE56 and SBE39plus temperature recorder

The SBE 39plus and the SBE56 are high-accuracy temperature recorders with internal battery pack and non-volatile memory. They are intended for moorings or other longterm, fixed-site applications and are rated for 10,500 meters with a titanium housing (SBE39plus) and 1,500 m with a plastic housing (SBE56), respectively.

The start time and configuration of all 5 SBE39plus and 3 SBE56 were the same. The starting time was set to 18.05.2018 at 08:00. The measurement interval was set to 60 s.

6. Station List

Station No.	Date	Gear	Time	Latitude	Longitude	Water depth (m)	Remarks
1	2019-03-28	CTD	09:03	30° 12,992' N	26° 54,269' W	4858	Max. depth 2000m, only used for calibration
2	2019-03-29	Mooring	07:24	30° 29,027' N	30° 11,815' W	4533	Mooring successfully recovered
3	2019-03-29	CTD	11:03	30° 29,084' N	30° 10,354' W	4533	Max. depth 600m, only used for calibration

7. Data Availability

Type	Database	Available	Contact
Mooring time series	Pangaea	will be uploaded after final processing	jannak@uni-bremen.de
Vessel-Mounted ADCP outside EEZs	Pangaea	will be uploaded after final processing	jannak@uni-bremen.de

8. Acknowledgements

We thank Captain Matthias Günther and the entire crew of Poseidon for the friendly and cooperative atmosphere and their professional technical assistance. Klas Lackschewitz provided administrative support. Financial support came from the Deutsche Forschungsgemeinschaft (DFG) TRR 181 ‘Energy Transfers in Atmosphere and Ocean’, project ID 274762653.

9. References

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